U. S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Partulina variabilis*

COMMON NAME: Lanai tree snail, Pupu kani oe

LEAD REGION: Region 1

INFORMATION CURRENT AS OF: September 2005

STATUS/ACTION:

____ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status

____ New candidate

_X_ Continuing candidate

____ Non-petitioned

_X_ Petitioned - Date petition received: May 11, 2004

____ 90-day positive - FR date:

_X__ 12-month warranted but precluded - FR date: May 11, 2005

__N_ Did the petition requesting a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:

a. Is listing warranted (if yes, see summary of threats below)? yes

b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes

c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded. We find that the immediate issuance of a proposed rule and timely promulgation of a final rule for this species has been, for the preceding 12 months, and continues to be, precluded by higher priority listing actions. During the past 12 months, most of our national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements, meeting statutory deadlines for petition findings or listing determinations, emergency listing evaluations and determinations and essential litigation-related, administrative, and program management tasks. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken over the past 12 months, see the discussion of "Progress on Revising the Lists," in the current CNOR which can be viewed on our Internet website (http://endangered.fws.gov).

____ Listing priority change

Former LP: ____

New LP: ____

Latest Date species became a Candidate: 1994

____ Candidate removal: Former LP: ____

___ A – Taxon is more abundant or widespread than previously believed or not subject to

the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on biological vulnerability and threats to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Snails, Family Achatinellidae (snail)

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, island of Lanai

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Hawaii, island of Lanai

LAND OWNERSHIP: With the exception of a few small parcels in the town of Lanai City, the entire island of Lanai is privately owned by Castle and Cooke Land Company. All of the *Partulina variabilis* occur on land owned by Castle and Cook Land Company.

LEAD REGION CONTACT: Paul Phifer (503) 872-2823, paul_phifer@fws.gov

LEAD FIELD OFFICE CONTACT: Pacific Islands Fish and Wildlife Office, Lorena Wada (808) 792-9400, lorena _wada@fws.gov

BIOLOGICAL INFORMATION:

Species Description: The oblong to ovate shells of adult *Partulina variabilis* are 14 to 16 milimeters (mm) (0.5 to 0.6 inches (in)) long, have 5 to 7 whorls, and have a white base color with a variable number of spiral bands of varying width or with no banding. The shell may coil to the right (dextral) or the left (sinistral), and both types of shells can be found in a single population. The life histories and ecologies of these snail species are all very similar and are described here for the entire genus. *Partulina* tree snails obtain adult size in 4 to 7 years, growing from a live birth size of about 4.5 mm. Upon reaching adult size, the snails stop growing and form a thickened edge or lip along the opening of the shell. A snail may attain an age that exceeds 15 to 20 years. All members of the genus are hermaphroditic (Pilsbry and Cooke 1912-1914), and reproductive output is low with an adult snail giving birth to 4 to 6 live young per year (Hadfield *et al*. 1989).

Taxonomy: The Lanai tree snails and all other *Partulina* snails belong to the endemic Hawaiian subfamily Achatinellinae in the family Achatinellidae. There are four genera in this subfamily including the federally listed genus *Achatinella*, or the Oahu tree snails. The colorful *Partulina* tree snails are a major part of the Hawaiian land snail fauna, equaling the diversity of the

endangered *Achatinella* snails. The life histories of these closely related genera are similar, and each genus has radiated into over 40 species. While the Oahu tree snails are perhaps more spectacular in their color patterns, shells of the genus *Partulina* have diverse and colorful arrays of bands and stripes, are generally larger than the Oahu snails, and are more widely distributed (Pilsbry and Cooke 1912-1914), and are currently found on Maui, Molokai, Lanai, and Hawaii (Hadfield 1994).

There are three species of *Partulina* endemic to Lanai, *P. crassa*, *P. semicarinata*, and *P. variabilis*. The taxonomy of these snails was most recently revised by Pilsbry and Cooke (1912-1914) and all three are recognized as valid species. Pilsbry and Cooke is the most recent and accepted taxonomic write up for this species.

Habitat: The Lanai tree snails are arboreal and nocturnal, and graze on fungus and algae growing on the surface of leaves (Henshaw *in* Pilsbry and Cooke, 1912-1914; Hadfield and Miller 1989). The snails occur on a wide variety of native plants and are occasionally observed on alien vegetation. *Partulina variabilis* was historically found in the mesic and wet forests on the island of Lanai (Pilsbry and Cooke 1912-1914).

Historic and Current Range Distribution:
Historic populations of *Partulina variabilis* were restricted to the wet and mesic ohia forests on the island of Lanai. While there are no historic population estimates, qualitative accounts of tree snails indicate that they were widespread and abundant in their habitat, with any single species probably numbering in the tens of thousands. In 1994, field surveys were conducted throughout the remaining native habitat (820-1,018 meters (m) (2,690-3,339 feet (ft)) in elevation) of the historic range, indicating that the few remaining individuals are restricted to small isolated populations (Hadfield 1994). *Partulina variabilis* was observed at 16 locations, and a total of 175 individual were seen (28 adult, 111 juvenile, and 36 newborn snails). Some of the sightings occurred in conjunction with a closely related and equally rare sister species, *Partulina semicarinata*. All of the populations of these snails had only 1 to 2 adults and were found on the following host plants: ohia (*Metrosideros polymorpha*), kanawao (*Broussaisia arguta*), kopiko (*Psychotria* sp.), pilo (*Coprosma* spp.), pelea (*Melicope* sp.), and dead hapuu fern (*Cibotium glaucum*). Alien vegetation used by *Partulina variabilis* includes guava (*Psidium gunjava*) and New Zealand ti (*Cordyline australis*) (Hadfield 1994).

In 2005, Dr. Michael Hadfield resurveyed all of the original sites from the 1994 survey and surveyed a newly discovered site. Ten of the sites resurveyed contained only *Partulina variabilis* and two sites contained both *Partulina variabilis* and *Partulina semicarinata*. Four of the original sites surveyed were searched but no *Partulina variabilis* were found. A total of 90 *Partulina variabilis* were observed in 12 out of the 17 sites surveyed. The *Partulina* species were found in a variety of native vegetation including kanawao (*Broussaisia arguta*), kopiko (*Psychotria* sp.), pilo (*Coprosma* spp.), pelea (*Melicope* sp.) and ohia (*Metrosideros polymorpha*). Most of the ohia were of the “glabrima” form, fairly short (under 3 m), shrubby, and with yellowing leaves potentially indicating damage from spiraling whitefly (*Aleurodicus disperses*). Nonnative plant species the snails were located on include New Zealand ti (*Cordyline australis*) and New Zealand flax (*Phorium tenax*).

THREATS:

A. The present or threatened destruction, modification, or curtailment of its habitat or range.
Removal of forests and the introduction and spread of invasive vegetation began with the prehistoric arrival of the Polynesians and accelerated after the arrival of Europeans in 1778 (Hobdy 1993). The 2005 survey report noted that some areas containing native forest in 1994 had become dominated by nonnative plants and that these sites no longer contain many snails (Hadfield 2005).

Forests not cleared for agriculture were invaded by feral cattle, horses, goats, deer and pigs (Baldwin 1887). The grazing activities of these mammals reduced the forest understory, prevented recovery by native plants, and aided the invasion of exotic plants by spreading their seeds and creating disturbed areas where seeds could germinate (Hobdy 1993).

At the present time on Lanai, axis deer (*Axis axis)* are a serious threat to the native forests and habitat of *Partulina variabilis*. This alien deer is managed by the private landowner and the State of Hawaii as a game species. Reforestation with nonnative species such as eucalyptus, ironwood, and Norfolk pine has also contributed to the loss of tree-snail habitat. Forest fires have a particularly catastrophic effect on snail populations as well as their habitats. Alteration of the forest canopy and understory by all of these agents have resulted in changes in moisture and humidity which further inhibit the recovery of native forests to suitable habitat for native tree snails (Pilsbry and Cooke 1912-1914).

The Private Stewardship Grant Program contributed funds to fence approximately 1,600 hectares (3,900 acres) of the Lanaihale Summit. All of the known habitat occupied by this species will be included within this enclosure. This restoration effort will remove feral ungulates within the fenced are and then restrict feral ungulates from regaining access to the area. The fencing and removal of feral ungulates will allow restoration and natural regeneration of native plants to occur. Approximately 1/3 of the project is expected to be complete in 2006. However, until the fencing is complete and ungulates are removed, feral ungulates will continue to have access to areas where *Partulina variabilis* occur and the fence will not eliminate predators.

B. Overutilization for commercial, recreational, scientific, or educational purposes.
The collection of tree snails is ~~still~~ known to occasionally occur and ~~must~~ is viewed as a potential threat to the further survival of the species. For the remaining few *Partulina semicarinata,* the collection of a single adult snail can remove all or a large percentage of the reproductive population from a bush or tree, thereby driving that population closer to extinction.

C. Disease or predation.
Rats (*Rattus rattus, R norvegicus,* and *R. exulans*) serve as the major predators on extant populations of Hawaiian tree snails. In particular, the black rat appears to be a major threat to *Partulina variabilis* on Lanai (Hobdy 1993; Hadfield 1994). The black rat became widespread on Oahu in the 1870s (Atkinson 1977 and Perkins 1899). In 1887, Baldwin noted that it was not uncommon to find large numbers of shells around the lairs of rats and mice (Baldwin 1887). Kondo mentions in his field notes from the 1950s (Appendix II) that *Achatinella* shells damaged

by rats were common beneath the snail trees at many locations. The best documented example of the impact of rats on tree snails comes from Hadfield *et al.* (1993). The study site at which the rat population irruption occurred had been surveyed once a month for 4.5 years prior to the irruption. On the basis of shells recovered on the ground at each visit, Hadfield and his colleagues estimated that about 10 percent of the shells of *Achatinella mustelina* had been broken by rats. Between January and April 1988, rats increased in this well-studied site and killed about half of the snails in the population. The rats selectively preyed on larger snails, eliminating about 76 percent of the reproductive adults, and 72 percent of snails over 15 mm (0.6 in) in length. Only 16 percent of the snails less than 15 mm (0.6 in) long were killed by rats.

Other possible predators that occur on Lanai include terrestrial flatworms (*Geoplana septemlineata* and *Platydemis manokwari*), which have been reported to feed on snails (Mead 1979) and the terrestrial snail *Oxychilus alliarius* (Severns 1984). Most recently, the predatory flatworm *Platydemis manokwari*, has been found on the islands of Oahu and Hawaii. It is probably on all of the main islands and may pose a threat to all of Hawaii's tree snails. Observations on Guam have documented the devastating impact of this predator of the native tree snail fauna of that island (Hopper and Smith 1992; B. Smith, University of Guam, pers. comm. 1995).

Euglandina rosea was introduced to Hawaii between 1955 and 1956 by the Hawaii State Department of Agriculture in an effort to control the African snail, *Achatina fulica* (Hadfield and Kay 1981). *Euglandina rosea* is a voracious predator on terrestrial and arboreal snails and is responsible for the extinction of all eight species of the *Partula* tree snails on the island of Moorea in French Polynesia (Tillier and Clarke 1983; Clarke *et al.* 1984; Murray *et al.* 1988; Griffiths *et al.* 1993). *Euglandina rosea* follows mucous trails of other gastropods (Cook 1985) and will climb trees and bushes to capture its prey. Since its introduction, *E. rosea* has spread to low and high elevations throughout the Hawaiian Islands and has been the cause of local extinctions of many populations of *Achatinella* (Michael Hadfield, University of Hawaii, pers. comm. 1983 to 2005).

Though *Euglandina rosea* is not known to occur on Lanai, during the 2005 survey, the researchers were informed by Castle and Cook Land Company that an individual *Euglandina rosea* was recently brought to their Lanai field office. No other information was provided about the collection of this individual but this introduction could devastate the remaining tree-snail communities on Lanai (Hadfield 2005).

There are no efforts to reduce the rats where *Partulina variabilis* occur or to prevent *Euglandina rosea* from getting established on Lanai.

D. <u>The inadequacy of existing regulatory mechanisms</u>.
Currently, no formal or informal protection is given to *Partulina variabilis* by Federal or State agencies.

E. <u>Other natural or manmade factors affecting its continued existence</u>.
Even if the threats responsible for the decline of this species were controlled, the persistence of existing populations is hampered by the small number of extant populations of 90 individuals

and the small geographic range (12 sites on Lanaihale) of the known populations. This circumstance makes the species more vulnerable to extinction due to a variety of natural processes. Small populations are particularly vulnerable to reduced reproductive vigor caused by inbreeding depression, and they may suffer a loss of genetic variability over time due to random genetic drift, resulting in decreased evolutionary potential and ability to cope with environmental change (Lande 1988; Center for Conservation Update 1994). Stochastic physical events such as hurricanes and droughts could eliminate one or more of the eight remaining populations. This is especially true due to several life-history features of this and all other *Partulina* tree snails (Hadfield 1986; Hadfield and Miller 1989, 1993; Kobayashi and Hadfield 1996): adults require 4 to 7 years to reach sexual maturity; reproductive rates are low; eggs are not laid as in most terrestrial snails, rather the young emerge fully developed from the parent; dispersal is very limited, with most individuals remaining in the tree or bush on which they were born. All of these traits make these snails very sensitive to any event that could lead to a reduction or loss of reproductive individuals.

A total of 9 *Partulina variabilis* were collected in 2000 for captive propagation. Currently there are 135 specimens in the Endangered Snail Lab located at the University of Hawaii Manoa campus. Though this population is protected from the effects of droughts, the effects of severe storms may still impact this population as evidenced by the loss of snails when a severe storm flood interrupted power supply to the University on October 30, 2004. Though lab staff was able to respond within hours, the extended temperature increase had an adverse impact on the snails and death rates were double what was ordinarily observed. In addition, these snails are likely subjected to the same concerns of reproductive vigor and loss of genetic variability.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

Currently, a captive propagation program is underway at the University of Hawaii for Oahu tree snails in the genus *Achatinella* as well as some of the species of *Partulina*. At the present time, there are 135 *Partulina variabilis* in captive propagation. This captive propagation program has a long standing record of success and is tied to efforts to reintroduce the snail species into secure field locations within their historic range.

In 2000, the Pacific Islands office entered into an agreement with the major landowner of the island of Lanai to fence 1,600 hectares (3,900 acres) of upland forest that currently supports the remaining Lanai tree snails. The first third of this project is currently being worked on and expected to be completed in 2006. Axis deer and any other ungulates will be removed from the fenced area and thus help secure tree snail habitat from further degradation. In addition, in 2003, a Memorandum of Agreement was signed between the U.S. Fish and Wildlife Service and the major landowner of the island of Lanai for additional fencing and management of alien species. This additional fencing and management will contribute to protecting snails and their habitat from habitat degradation by ungulates. Additional management will be needed to remove the threat of predation by rats.

SUMMARY OF THREATS:

A review of the historic records plus more recent surveys indicates that *Partulina variabilis* is highly threatened, as is *Partulina semicarinata*. The third Lanai species, *Partulina crassa*, is most likely extinct. Predation by rats, loss of habitat (to agriculture and the impacts of alien

ungulates), and the massive spread of nonnative plant species are the major factors contributing to the decline of these snails.

The greatest threats to *Partulina variabilis* are rat predation, loss of habitat and vulnerability of small population size. On-going conservation efforts will benefit this species when the fence is completed and feral animals are excluded from their habitat. Until then, habitat is likely to continue to be degraded. There are no efforts to remove rats from *Partulina variabilis* habitat. If *Euglandia rosea* become established on Lanai they will pose a significant threat as well.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	**2***
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude:

This species is highly threatened throughout its limited range by habitat loss and modification and by predation from rats. No efforts are being undertaken to remove rats in areas that *Partulina variabilis* occur. The threat for this predator is expected to continue or increase unless the rats are actively controlled or eradicated. Habitat loss also continues due to the detrimental impacts nonnative ungulates have on the native vegetation required by *P. variabilis*. Although the snails are in an area to be fenced, until the fence is constructed and the ungulates have been removed, the habitat will continue to be degraded. The small number of individuals and the small number of populations make this species very susceptible to the negative effects of stochastic events such as hurricanes and storms. Though this population is protected from the effects of unexpected droughts, the effects of severe storms may still impact this population as evidenced by the loss of snails when a severe flood interrupted the power supply to the University and temperatures increased within the environmental chambers containing the snails. In addition, these snails are likely subjected to the same concerns of reproductive vigor and loss of genetic variability.

Imminence:

Threats to *Partulina variabilis* from habitat loss and predation by rats are imminent due to the on-going nature of these threats. Although the snails are in an area to be fenced, until the fence is constructed and the ungulates have been removed, the habitat will continue to be degraded and the snails will continue to be predated by rats.

Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed? yes

Is Emergency Listing Warranted? No. The species is not considered for emergency listing at this time because the immediacy of the threats is not so great as to imperil the taxon within the time frame of the routine listing process. In addition, the snail's habitat is in the process of being fenced. If it becomes apparent that the routine listing process is not sufficient to prevent large losses that may result in extinction, then the emergency rule process for this species will be initiated. We will continue to monitor the status of *Partulina variabilis* as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

DESCRIPTION OF MONITORING:

In 2005, a survey was conducted of the areas surveyed in 1994. This level of monitoring is appropriate to update the status of the species since all previously known sites were revisited by the original principal investigator. The results of the survey are included in this assessment.

The taxonomic status of the species is verified by Pilsbry and Cooke. The Hawaii Biodiversity and Mapping Program lists this species as critically imperiled (Hawaii Biodiversity and Mapping Program Database 2004). This species is listed as endangered in the International Union for Conservation of Nature and Natural Resources Red Data List database (International Union for Conservation of Nature and Natural Resources database 2004).

List of Experts Contacted:

Name	Date	Place of Employment
Dr. Michael Hadfield	July 11, 2005	University of Hawaii
Betsy Gagne	July 12, 2005	Hawaii Natural Area Reserves System Commission
Dr. Robert Cowie	July 11, 2005	University of Hawaii

List of Databases Searched:

Name	Date
Hawaii Biodiversity and Mapping Program	2004
International Union for Conservation of Nature and Natural Resources	2004

COORDINATION WITH STATES:

In October 2004 we provided the Division of Forestry and Wildlife Administrator, Paul Conry, with copies of our most recent candidate assessment forms for his review and comment. In addition, copies of the candidate forms were sent to Betsy Gagne, Executive Secretary for the

Hawaii Natural Area Reserves System Commission. Ms. Gagne reviewed the information for this species and provided no additional information or corrections (B. Gagne, pers. comm. 2005).

LITERATURE CITED

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: Acting _____ 11/10/05
Regional Director, Fish and Wildlife Service Date

Concur: _____ August 23, 2006
Director, Fish and Wildlife Service Date

Do not concur: _____ _____
Director, Fish and Wildlife Service Date

Date of annual review: 8/2/05
Conducted by: Lorena Wada, Pacific Islands FWO

Comments:

PIFWO Review

Reviewed by:

Gina Shultz _____ Date: 9/19/05
Assistant Field Supervisor, Endangered Species

Patrick Leonard _____ Date: 10/10/05
Field Supervisor